

A Review of Impacts of Climate Change on Birds: Implications of Long-term Studies

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Abstract: It is generally accepted that climate has changed greatly on a global scale, and that the earth's climate has already warmed by some degrees over the past century. Ample evidence shows that there have been apparent changes in avian population dynamics, life-history traits and geographic ranges in response to global climate change. This paper briefly reviews the possible effects of climate change on avian biology and ecology all over the world, with emphasis on new findings from several long-term studies in Europe and North America, which provide unique opportunities to investigate how long-term changes in climate affect birds at both individual and population levels. The implications of such long-term studies for future bird studies in China is discussed with hope that this review can contribute to the preparation and plan for studies of climatic effects on birds in China in the future.

Key words: Climate change; Global warming; Geographic range; Phenological change; Birds

气候变化对鸟类影响:长期研究的意义

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摘要: 过去一个多世纪全球气候发生了明显变化, 地球表面温度正在逐渐变暖。已有大量研究结果表明, 鸟类已经在种群动态变化、生活史特性以及地理分布范围等方面对全球气候变化作出了相应的反应。根据全球范围内气候变化对鸟类影响的研究资料, 尤其是北美和欧洲的一些长期研究项目的成果, 综述了气候变化对鸟类分布范围、物候、繁殖和种群动态变化等方面的可能影响。这些长期研究项目为探讨气候变化在个体和种群的水平上如何长时间地影响鸟类提供了独特的机会, 对未来中国鸟类学研究也会有所裨益。

关键词: 气候变化; 全球变暖; 地理范围; 物候变化; 鸟类

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It is reported that global mean surface temperatures have increased 0.6°C since the late 19th century, and by 0.2 – 0.3°C over the past 40 years. Climate models predict that the mean annual global temperature will increase by 1 – 3.5°C by 2100, with warming more pronounced at higher latitudes (IPCC, 1995, 2001). Recent warming has been the greatest over continents between 40°N and 70°N and relatively greater increases are expected in winter than in summer (IPCC, 1995).

With the advent of such phenomena, there has been a growing concern among biologists and ecologists about how global climate change may affect the distribution, phenology and life history traits of plants and animals. There is thus a renewed interest in the study of how species have responded to climatic changes in the past based on re-evaluation of many long-term data sets. Birds, as an assemblage of organisms, are sensitive to environmental and climatic changes, and have

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thus long been used as a useful objective indicator of global changes. Therefore, it is not surprising that numerous studies on the ecological effects of climate change on birds have been conducted in the past decades (e.g. Jarvinen 1994; Crick et al, 1997; Winkel & Hudde, 1997; Forchhammer et al, 1998; McCleery & Perrins, 1998; Visser et al, 1998; Bradly et al, 1999; Brown et al, 1999; Crick & Sparks, 1999; Saether et al, 2000; Dunn & Winkler, 1999; McCarty, 2001; Moss et al, 2001; Walther et al, 2002; Crick, 2004; Nussey et al, 2005; Bradshaw & Holzapfel, 2006; Anders & Post, 2006; Sokolov, 2006). All of these studies have investigated possible effects of climate change/fluctuation on several main aspects of avian biology and ecology, including avian distribution and geographic range, reproductive biology and performance, and phenological changes. In addition to changes attributed to phenotypic plasticity, recent studies show that over the past several decades, rapid climate change has led to heritable, genetic changes in animal populations. For example, the European blackcap (*Sylvia atricapilla*) has shown genetically based shifts in the timing of their seasonal reproduction, dormancy and migration during recent and rapid climate warming (Bradshaw & Holzapfel, 2006).

This paper reviews the effects of climate change on the distribution of birds, avian phenology and migration, and avian breeding performance and life history traits.

1 Effects on distribution and geographic range

Climate is an important determinant of geographic range for many species (Pearson & Dawson, 2003). Over the last 150 years, the annual average temperature in many places in the northern hemisphere has increased by up to a few degrees centigrade. It is demonstrated that a 3°C change in mean annual temperature corresponds to a shift in isotherms of approximately 300–400 km in latitude (in the temperate zone) or 500 m in elevation. Therefore, species are expected to move upwards in elevation or towards the poles in latitude in response to increasingly warm temperatures (Hughes, 2000; Pearson & Dawson, 2003; Hickling et al, 2006; Harrison et al, 2006).

Many mid-latitude bird species have increased in number and spread northwards, while other more northern species have declined and retreated further north. Such changes in range have usually been attributed to climate change (Burton, 1995). Poleward range ex-

pansions have been reported for birds in both Europe and the USA (e.g. Thomas & Lennon, 1999; Johnson 1994; Burton, 1995; etc.).

Thomas & Lennon (1999) analysed the distributional changes of breeding birds in Britain using two surveys, each completed on a 10 km grid system and compiled about 20 years apart (1968–1972 vs. 1988–1991). The northern limits of 59 species occupying southern Britain were found to have moved north during this period by an average of 19 km. On the other hand, the 42 northern species showed little change in the southern boundary of their ranges. As these changes occurred in a period of climatic warming, the authors suggested that the increasing warmth is the underlying causal factor.

A survey of 24 bird species in the western USA, whose nesting distributions have expanded over the past three decades, showed that 14 had shifted northward, compared with four moving southward, five moving westward and one radial expansion (Johnson, 1994). In the eastern USA, marked expansions have occurred in several other species, such as the Dickcissel (*Spiza americana*), Northern Cardinal (*Cardinalis cardinalis*), American Wigeon (*Anas americana*) and Gadwall (*Anas strepera*), and northward retreats in others, such as the Greater Scaup (*Aythya marila*) and Glaucous Gull (*Larus hyperboreus*) (Johnson 1994; Burton, 1995).

Although a number of factors have been proposed to explain these northward range expansions, the climatic explanations of such changes are mainly based on following facts: (1) many changes are latitudinal (towards the north in the Northern Hemisphere. For example, the long-term study by Thomas and Lennon (1999) presented very compelling evidence linking northward shifts of birds to climate change), and (2) in many bird species, reproductive and survival rates are clearly influenced by prevailing weather (e.g. Winkel & Hudde, 1997; Visser et al, 1998; etc.). Hence, resident species that suffer high mortality in harsh winters might be expected to increase and spread further north during a run of mild winters (Newton, 2003).

There may be other potential factors to explain the range expansions. For example, human impacts on habitat may have driven the relevant birds to move northward. Also there has been a relaxation in hunting pressure in recent decades in many places across the world, which may have enabled some species to recolonise areas from which they had previously been e-

minated (McCarty, 2001; Newton, 2003). Thus some of the range changes attributed to climate change might well have been caused by other factors or a combination of climate change and other factors. Almost always, uncertainty hangs over any explanations of range change, because the evidence is primarily correlative (Newton, 2003; Crick, 2004). Therefore it is unwise to make conclusions of the climatic effects on the range changes of birds without systematic and long-term monitoring and surveying programmes, and thus care needs to be taken in explaining the range change of birds in relation to climate change.

2 Effects on avian phenology and migration

The life cycles of many organisms are strongly influenced by temperature and precipitation. Phenology is probably the most easily recorded aspect of nature's response to climate change, and perhaps the most responsive. Life cycle events triggered by environmental cues, such as degree-days, might be altered, leading to decoupling of phenological relationships between species (Hughes, 2000).

Increasing evidence suggests that climate change has impacted on avian breeding phenology. Some bird populations in Europe and North America have shown this kind of response to climatic warming in addition to range changes. Many bird species began to breed progressively earlier in the later half of the twentieth century (Winkel & Hudde, 1996; Crick et al, 1997; Forchhammer et al, 1998; Visser et al, 1998; Dunn & Winkler, 1999). Many other studies have confirmed the link between spring temperature and laying dates in a wide range of birds, as well as between spring temperature and leafing dates of deciduous trees, spawning dates of amphibians and peak abundance dates of butterflies (Sparks & Crick, 1999).

Trends towards earlier reproduction have been found in several long-term studies of individual bird species in Europe and the USA (Crick, 1997; Crick & Sparks, 1999; Winkel & Hudde, 1996; Jarvinen, 1989; McCleery & Perrins, 1998; Visser, 1998; Bergmann, 1999; Brown et al, 1999). For example, long-term studies of Great Tits (*Parus major*) in Wytham Wood provide clear evidence that they have responded to long-term trends in spring temperature by advancing their laying dates since 1970, after which there has been a generally upward trend in spring temperature (McCleery & Perrins, 1998). Intensive studies of the Pied Flycatcher (*Ficedula hypoleuca*) in Finland (Jarvinen, 1994), Collared Flycatcher (*F. albi-*

collis) in Poland (Przybylo et al, 2000), Blue Tits (*P. Caeruleus*) and Great Tits in Germany (Winkel & Hudde, 1997) and Goldeneye (*Bucephala clangula*) in Germany (Ludwichowski, 1997) all show similar results.

The British Trust of Ornithology's Nest Record Scheme may provide the best evidence for this impact. The scheme started in 1939 and currently receives about 30 000 individual nest records each year, which are used to monitor the breeding performance of birds in the UK. An initial analysis of the data on egg-laying dates for 65 species over a 25-year period (1971 – 1995) revealed that 20 of the species were laying significantly earlier than before in recent years, with only one species (Collared Dove, *Streptopelia decaocto*) laying significantly later (Crick et al, 1997). The average advancement of laying date for the 20 species was about nine days. This nine day difference in laying date is similar to the six to eight day earlier growing season of plants in northern latitudes revealed by satellite measurements (Keeling et al, 1996). A subsequent analysis of the data over a 57 year period (1939 – 1995) showed that, of 36 species, 31 showed statistically significant relationships between average annual laying dates and monthly average temperature and rainfall (Crick & Sparks, 1999).

In a study of marked individuals of the Mexican Jay (*Aphelocoma ultramarina*) in southeastern Arizona from 1971 – 1998, Brown et al (1999) found that the mean Julian date of first clutch in the population declined significantly by 10.1 days. The date of the first nest in the population also became earlier by 10.8 days. These trends were associated with significant trends towards increased monthly minimum temperature in the study area. A significant trend towards warmer minimum temperature in the months before and during the initiation of breeding was observed from 1971 to 1998.

A long-term study of Blue Tits (1950 – 1998) and Great Tits (1952 – 1997) throughout the western Palearctic zone (Sanz, 2002) demonstrated that both Great Tit and Blue Tit females lay eggs earlier after warmer, moister winters, and there was an advancement of laying date for most of the populations studied.

It may be debatable that, besides temperature, laying date in birds may be influenced by many other factors such as latitude, longitude, breeding density, intra-species competition and elevation. However a 40 year study of Tree Swallows (*Tachycineta bicolor*) across North America, which controlled for the effects

of such factors, has still shown that the egg laying date advanced by up to nine days during 1959 – 1991 (Dunn & Winkler, 1999). This advancement in egg laying date of Tree Sparrows was associated with increasing surface air temperature at the time of breeding. They therefore concluded that Tree Swallows across North America are breeding earlier and that the most likely cause is a long-term increase in spring temperature.

The mechanisms for earlier laying in Tree Sparrows, as well as in other studied species, is probably an advancement in the date of emergence or peak abundance of aerial insects (Dunn & Winkler, 1999), which is directly related to air temperature. Studies (e. g. see Visser et al, 1998) have shown that timing of breeding is related to the abundance of aerial arthropods in many aerial insectivorous bird species. Another possible mechanism can be that higher spring temperature could advance laying directly by reducing the energy requirements of pre-reproductive females (Dhondt & Eyckerman, 1979).

As a general rule, for insectivorous birds, the abundance of arthropods at the time of maximum food requirement of their young is a crucial determinant of nesting success (Lack, 1968; Perrins, 1991). Spring temperature determines the peak date of caterpillar biomass (Visser et al, 1998; Visser & Holleman, 2001). Synchrony between the date at which caterpillar biomass peaks and the breeding phenology of birds is the main selective pressure on the timing of breeding in some passerine birds (Blondel et al, 1993; Noordwijk et al, 1995). Buse & Good (1996) have experimentally demonstrated that oak trees open their buds earlier at elevated temperature. An increase in spring temperature may also trigger the earlier emergence of caterpillars (Visser & Holleman, 2001) and developmental periods of caterpillars can be shortened (Buse et al, 1999). It is therefore predicted that climatic warming would change the synchronization between timing of avian breeding and food availability.

However, not all insectivorous passerine birds studied over the past century showed a significant trend towards earlier onset of breeding with climatic fluctuations (Crick et al, 1997; Winkel & Hudde, 1997; Crick & Sparks, 1999). Moreover, there are regional differences in response to climate change among breeding populations of the same species at similar latitudes and habitats. One example is that a long-term study on the Great Tit in Holland failed to show such advancement in egg laying (Visser et al, 1998), whereas a

British population did so (McCleery & Perrins, 1998). There is even a mismatch between the time of reproduction and the time of food abundance for the population of Great Tits in Holland (Visser et al, 1998). Such a mismatch between laying date and peak food availability may be because the conditions for reproduction and selection may have changed at different rates (Visser et al, 1998). Firstly, the constraints on the timing of egg laying may not have changed in the same way as food availability for the young. Secondly, the predictors on which commencement of breeding are based may not have changed over the years in the same way as the food availability for the young (Visser et al, 1998). Evidence has demonstrated that the warmer temperature allows caterpillars to halve their developmental time from 56 to 23 days, but the Tits are unable to alter the time length of incubating their eggs. Thus later fledged broods face lower food availability than normal and this appears to result in the lower likelihood that they will form part of the breeding population in the next year (Visser et al, 1998). This leads to a decline in lifetime reproductive success of the birds (Nussey et al, 2005).

There are several possible consequences of changes in laying date for bird species. In many birds, laying earlier is associated with larger clutch size and more young fledged (Lack, 1968; Price & Liou, 1989; Dunn & Winkler, 1999). Thus, warmer temperature might lead to a greater production of young. However, recent evidence from Great Tits in Holland, as described above, suggests that warmer spring temperature can lead to earlier maturing of caterpillars, the main food for the young of Tits, before the Tit chicks hatch. This creates a mismatch in the timing of egg laying relative to the availability of food for nestlings and, as a result, later laying females may produce fewer surviving young (Visser et al, 1998; Nussey et al, 2005). Further studies on both the precise mechanisms and demographic consequences of climate change on birds are thus needed (see also Montevecchi & Myers, 1997; Harrington & Sparks, 1999).

In addition to the effects of climate change on the onset of reproduction in birds, some evidence has also demonstrated that the effects of large-scale weather patterns exist on migrants' arrival time.

A long-term and continued recording of arrival time of several migrant bird species in the UK exists. The Royal Meteorological Society (RMS) coordinated a national network of phenological recorders during 1875 – 1947, which provided recordings of arrival time of

the traditional harbingers of spring such as the cuckoo and swallow (Sparks et al., 2002). In addition to the RMS scheme, records of first arrival commenced at local county level in the last quarter of the nineteenth century. More and more records are available from individuals and from organizations such as the British Naturalists Association. Since 1998, the UK Phenology Network has been operating a large national scheme and the British Trust for Ornithology (BTO) commenced Migration Watch in 2002. All of these data provide a huge resource from which the influence of climate on arrival time of birds can be examined (Sparks et al., 2002).

Based on these long-term records, Huin & Sparks (1998) demonstrated that swallow arrival time was influenced by temperature: two days earlier for each 1°C warmer. The swallow arrival times have become progressively earlier in the last two decades, leading to their adoption by the UK government as a climate change indicator (Cannell et al., 1999). There are fewer data available on departure dates of birds, but Sparks & Mason (2001) still reported an overall trend to later departure of some birds over the last 50 years in the UK.

Climate change may have differential effects on migration timing for long- and short-distance migrants. A 42 year study of 65 migrant bird species was conducted by Jenni & Kery (2003) at the Alpine pass Clo de Bretolet Switzerland, which is the only migration passage for most of the species, to determine the effects of climate change on the timing of autumn migration. The autumn passage of migrants wintering south of the Sahara (long-distance migrants) has advanced in recent years, but those migrants that winter north of the Sahara (short-distance migrants) have delayed their autumn migration. The authors argued that this difference in migration time may be a result of the differential selection pressure on these birds. The long-distance migrants migrate earlier in order to cross the Sahel area before the dry season commences in September. The short-distance migrants winter in the Mediterranean area, or in the breeding grounds that offer milder conditions owing to global warming.

Under the conditions of substantial global warming (1989 – 2001), the dates of bird arrival in southern Lithuania are becoming markedly earlier for both short- and long-distance migrants (Zalakevicius, 2001). Increasing temperatures induce a total shift in the spring arrival of birds, changing the time of both its beginning and end. The most marked differences in the arrival

dates were observed at the beginning of the arrival season. This is more typical of short-distance migrants and less significant for long-distance migrants (Zalakevicius, 2001).

Under the impact of climate change, changes may occur in migratory state, migration routes, migration distances and directions, places of staging and wintering, as well as migration intensity.

Although global warming has a unidirectional effect on the onset of reproduction of most bird species studied (Crick et al., 1997; Visser et al., 1998; Both & Visser, 2001, but see above), Jenni & Kery (2003) shows that effects on the timing of subsequent events of the annual cycle (e.g. arrival time and departure time) may be complex and opposite. The effect (advance or delay) and its extent vary according to the ecology and life history of a particular species. Short-distance migrants may benefit from global warming in several aspects: earlier start of reproduction, increased reproductive output owing to a prolonged breeding period, better conditions in the breeding areas after the breeding season and shortening migration distance (see Berthold 1990; Pulido et al., 1996). In contrast, long-distance migrants may not obtain the same benefits from global warming; their autumn migration timing may be constrained by the onset of the dry season in the Sahel area rather than the conditions in the breeding areas. Global warming may be a serious threat to some long-distance migrants (Jenni & Kery, 2003).

In addition to North America and Europe, a long-term study in the Mediterranean basin, involving six migratory bird species, also found that they were trending towards advancement in spring arrival (Gordo & Sanz, 2005).

Similar accounts of the differential effects of climate change on avian migration can also be found elsewhere. Berthold (1990) expects that a global increase in the average air temperature will change bird life in general and migratory systems in particular. More specifically, residents will benefit from a decrease in winter mortality and an increase in reproductive output. Partially migrant populations may rapidly shift to sedentariness and short-distance migrants may shorten their migration distances. With an overall increase in resident competition for resources, long-distance migrants may decline further. General decline of avian diversity can thus be expected (Berthold, 1990). Evans (1997) pointed out three possible scenarios of a large-scale impact of climate change on bird migration: birds may follow shifting floral belts; migrants may change their

routes and become wanderers when habitats are rapidly changing in their staging areas; or geographical variations of temperature and precipitation could cause desynchronization on migration routes.

Most previous studies of migration phenology were conducted on the basis of sighting records of first arriving individuals, and such records may bias the results towards earlier arrival dates (Sparks & Mason, 2001; Tottrup et al, 2006). However, a study of phenology of 25 migratory species of birds on the Christiansø Island, between 1976 and 1997, used four measures of arrival (first individual, first 5%, 50% and 95% of the total number of trapped individuals) to test for changes in arrival time (Tottrup et al, 2006). Their study confirmed earlier spring arrival of these birds with an average earlier arrival of 0.26 days per year. They therefore concluded that analyses of first arriving individuals may provide a rough indication of the direction of the population timing. However data and analyses of the entire migration period are necessary to get a more appropriate and precise picture of what causes the changes in timing of migration.

The changes in bird migration timing do not seem to match changes in plant and invertebrate phenology, and the consequence of this need to be considered seriously. It is also very important to establish a link between arrival times and other aspects of the life cycles of birds at both individual and population levels in order to understand the flow-on effects of a changed phenology (Sparks et al, 2002).

3 Effects on breeding performance and population dynamics

Many studies have demonstrated that ecological and population processes are affected by large-scale climatic fluctuations in many vertebrate species (e.g. Saether et al, 2000; Sillett et al, 2000; Stenseth et al, 2002; Jenouvrier et al, 2003). In the Northern Hemisphere it has been shown that climatic fluctuations associated with the North Atlantic Oscillation (NAO) have important effects on animal populations (Post & Stenseth, 1998; Post et al, 1999). There is good evidence that birds are changing the timing of their nesting seasons (e.g. Crick & Sparks, 1999; Dunn & Winkler, 1999; Sanz, 2002), but there is also evidence that other aspects, such as egg size, hatching success, nesting success and demographic dynamics, are changing in response to climate change (Jarvinen, 1994; Winkel & Hudde, 1997; Barbraud & Weimerskirch, 2001; Reid & Croxall, 2001; Jenouvrier et al, 2003).

Life-history theory predicts that animals will vary their investment in reproduction depending on their survival prospects relative to those of their young (Horn & Rebenstein, 1986). Any global environmental change that warmed northern areas would mean that females may have better opportunity to invest resources in eggs and hence in hatching and nestling survival (Jarvinen, 1994). Since warmer weather may allow females to invest more resources in reproduction (Jarvinen, 1994) and accordingly may lead to larger eggs which protect developing embryos against cooling better than smaller ones (see Jarvinen, 1994). Thus, warmer weather may lead to relatively higher hatching success, and it is reasonable to predict that birds' reproductive strategies may alter in response to global climatic change. Such alteration has been observed by Jarvinen (1994) who found from 1975 – 1993 that the mean air temperature during the main egg-laying period of a Pied Flycatcher population in Finnish Lapland, correlated significantly and positively with mean egg volumes. Winkel & Hudde (1997) also reported that Pied Flycatchers tend to lay larger eggs and larger clutches and enjoy improved hatching and fledging success with climate warming.

Studies have shown that some seabirds are also sensitive to the variation of air temperature. It has been reported that rising temperature around the Antarctic Peninsula, and the associated shortening of the annual period with fast sea ice, have been accompanied by a decline in Antarctic krill (*Euphausia superba*) which is a crucial food-species for many bird and mammal species. This may be the reason why populations of several seabirds declined and years of poor breeding increased in frequency from 1980 – 2000 in South Georgia (Reid & Croxall, 2001). Decline in Macaroni Penguins (*Eudyptes chrysolophus*) and Black-Browed Albatrosses (*Thalassarche melanophris*) exceeded 50%. Further south, the Emperor Penguin (*Aptenodytes forsteri*) declined by 50% in the 1970s through increased mortality during a period of reduced sea ice (Barbraud & Weimerskirch, 2001). A 39 year (1963 – 2002) study of Southern Fulmars (*Fulmarus glacialis* Smith) has also confirmed this phenomenon. Jenouvrier et al (2003) revealed that the Southern Fulmar population dynamics were affected by sea ice concentration and sea surface temperature anomalies. This was predicted to be through an impact on krill availability, which is the main prey of Southern Fulmars. During warm anomalies, many fulmars skip breeding probably because the food availability was low and limiting for highly energy demanding reproductive

activities, indicating that fulmar population dynamics may be very susceptible to environmental variability.

At the population level, the effects of climate change may be different for different species depending on their specific ecological and demographic characteristics. For example, the effects of climate change on the population dynamics of long-distance migrants are different from those on short-distance migrants (see above). It is predicted that, during the next 50 to 100 years, Britain's avifauna will become more impoverished than today, with certain highly adaptable species and groups of birds becoming more and more dominant, while specialist species may suffer contractions in range and declines in population (Sparks et al, 2002).

Some recent studies have demonstrated that increases in global temperatures have caused, or have the potential to cause, additional population declines in birds (Both et al, 2006; Anders & Post, 2006). Both et al (2006) have shown that climate-change-induced mistiming (mismatching between the timing of peak food availability and nestlings) in the migratory Pied Flycatcher (*Ficedula hypoleuca*) has led to a population decline of about 90% during the past two decades.

4 Summary

Although no consensus has been reached among academics about the specific impacts of climate change on birds, ample evidence has demonstrated the ecological consequences, including impacts on their geographical distribution, migration phenology, breeding performance and population dynamics. Climate change is a long-term cumulative process, and its ecological consequences are complex and multi-factorial. Therefore, great care needs to be taken in explaining the effects of climate change on birds as pointed out by Newton (2003), and other possible factors also need to be controlled for when investigating impacts of climate change on birds as in Tøttrup et al (2006) and Dunn & Winkler (1999).

Further work needs to be undertaken on the potential impacts of climate change on avian biology and ecology and on the underlying mechanisms of its impacts. Particularly, studies are required to investigate the impact of climate change on breeding performance and the knock effects on the population dynamics of wild birds, as this is directly related to the management and conservation of wild birds. Only appropriate data sets accumulated over a long time can possibly reveal the true link between climate change and the ecological responses of birds. Long-term studies provide a unique

opportunity to observe how changes of the physical environment (including climatic changes) affect the biology and ecology of birds at both individual and population levels on long-time scales. In this respect, long-term data sets are highly valuable and will need to be maintained to ensure appropriate monitoring of potential impacts of climate change in the future (Sparks et al, 2002). Further analyses of existing long-term data sets will be important to identify vulnerable species and communities. However, because such data sets are relatively rare, particularly in China, establishment of new baseline monitoring programmes will also be important (Hughes, 2000).

5 Some thoughts for future research in this field in China

China is a country rich in bird species and vulnerable to environmental variability. However very few studies, especially long-term studies, have been conducted to investigate the potential effects of climate change on the ecology and biology of birds in China, except for a recent review of the impact of climate change on the distribution of several species of birds in China and a single study on cranes (Sun & Zhang, 2000; Ma et al, 2001). There is a clear difficulty in studying the effects of climate on organisms, as such effects are always entangled with other abiotic (e.g. latitude and altitude) and biotic (e.g. inter- and intra-specific competitions and density) factors. However it is still possible to disentangle the climatic effects from other effects through carefully designed and implemented long-term studies, as demonstrated by those mentioned in this paper.

The study of climate change impacts on wild birds has increasingly been a hot topic in recent years. However, compared to the rich bird resources, China has lagged behind this trend. Very few long-term studies or data sets (if any) exist in China investigating the long-term effects of climate change on birds; the authors thus recommend that studies be initiated in the near future to investigate the ecological and biological responses of bird to climate change in China. As no long-term records or data sets exist in China on distribution ranges, migration phenology and breeding ecology in relation to climate change, initial studies could start with systematic and critical analyses of data relating avian biology and ecology to environmental conditions which have been recorded and published in previous studies. Such analyses, combined with analyses of climate change trends in the same period, could hopefully

reveal some evidence for climate change impacts on birds in China. At the same time, a systematic and critical analysis of methodology used in the papers mentioned above is necessary to help appropriate design and implementation of possible long-term studies in China. A network of bird enthusiasts could be set up to help monitor and record some phenological events of wild birds across the country under the guidance of professional organizations like the China Ornithological Society (COS). Preliminary analyses could be conducted on possible existing data sets recorded by the State Bird Ring Center. Cooperation with different experts and institutions will be very important, as the impacts of climate change on birds can be both direct (through individual thermoregulation) and indirect (through impact on habitat and food) and thus involve many different disciplines such as vegetation ecology, entomology, modeling, avian ecology and biology and climatology.

Although few long-term data sets on climate change impacts on birds in China exist, many facilities which are capable of recording such data have been established across China. For example, some organizations and agencies, particularly some institutes of the Chinese Academy of Sciences, and the State Forestry Administration, have established many environmental monitoring stations across the country for different purposes. None of these monitoring stations were set up to collect data of climate change impacts on birds, but

many of them can be used to collect such data in addition to their daily operational purposes. In this way, better use can be made of existent facilities to conduct long-term studies of climate change impacts with systematic and consistent study design. Another advantage is the large variety of geographical areas and latitudes covered by the various monitoring stations which can provide climate change impact data from different habitats and latitudes. Furthermore, advantage should be taken of the national wildlife surveying program, undertaken every five years by the State Forestry Administration to help collect and compile distribution and range data of birds in relation to climate change. The scientific community needs to consider how to make the best use of relevant existing facilities and programs in the future design of studies on the climate change impacts on birds in China.

China has very much lagged behind in the study of impacts of climate change on birds, but it is still not too late to initiate such studies.

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《动物学研究》荣获云南省优秀期刊奖

2006 年 10 月 31 日，云南省新闻出版局在云南新闻出版教育培训中心举行了云南省第二届优秀期刊颁奖大会。大会在隆重而热烈的气氛中进行。云南省新闻出版局张德文局长首先讲话，他说：“十年耕耘洒辛勤汗水，金秋十月结丰硕果实。今天，我们在这里举行第二届云南省‘云电杯’优秀期刊评选颁奖大会，这是我省期刊出版史上的一件大喜事，我代表新闻出版局向大会表示热烈祝贺，向全省期刊出版工作者表示崇高的敬意，并对半年来付出辛勤劳动的各位评委表示诚挚的感谢。”张德文局长在随后的讲话中，就十年来我省期刊出版成就进行了总结，就这次评选活动的情况和最终结果做了介绍，并对今后工作提出了三点要求。讲话结束后，张德文局长、艾罕炳副局长、报刊处刘水云处长和马俊芳副处长，云南省期刊协会第二届理事会会长顾颂奇等在音乐声中为获奖刊社(编辑部)和人员一一颁奖；颁奖间隙，《云南社会科学》副主编黄淳、《林业调查规划》副主编许易琦、《漫画派对》主编张军分别代表获奖刊社(编辑部)发表了获奖感言。

本届云南省优秀期刊评选活动，距上届评奖活动相隔十年。其主旨是促进我省期刊的进一步繁荣与健康发展，展示我省期刊取得的新成就，发挥优秀期刊在期刊出版业中的示范作用，力举编辑优秀人才，打造品牌期刊，为加快我省文化产业的发展做出贡献。这次评奖活动共设优秀期刊、优秀期刊提名、优秀主编、优秀编辑、优秀栏目、优秀装帧 6 个奖项。共有省内 95 种期刊角逐评比，占全省期刊的 75%。其中，社科期刊 58 种、科技期刊 37 种。评选工作秉承公开、公平、公正的原则，历时半年，经过评委对参评资格、出版规范、编校质量的细致审查，再由评委会进行认真严格的评比筛选，最终评选出本届优秀期刊奖 16 名、优秀期刊提名奖 27 名、优秀主编奖 30 名、优秀编辑奖 81 名、优秀栏目 65 个、优秀装帧奖 23 个。

云南省科技期刊首次参评，为这次活动凸现了亮点。科技期刊中，获优秀期刊奖的有 6 名，分别是：《云南大学学报》(自科版)、《动物学研究》、《蜜蜂杂志》、《红外技术》、《奥秘》、《云南林业》；获优秀期刊提名奖的有 11 名，获优秀主编奖的有 10 名，优秀编辑有 28 名，优秀栏目 23 个，优秀装帧 6 个。

(本刊编辑部)